GRINNELL, (J. S.)

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Machinery and Implements.

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AGRICULTURAL MACHINERY AND IMPLEMENTS.

The use of agricultural implements, coeval with the enforced cultivation of the soil by Divine command, — in sorrow, in the sweat of the face, and with thorns and thistles,— begins with the earliest date of recorded history; but thousands of years went by, and generation after generation, past numbering, returned to the earth from whence they came, and which they had painfully tilled, with but small improvement in the means by which they wrought out their daily living.

The rude instruments of husbandry sculptured on Assyrian walls and Egyptian tombs were continuously used by Eastern nations down to a comparatively modern date, and are not entirely given up yet in some portions of those countries; and even among those nations of Europe boasting themselves to be earliest the most refined and advanced in science and in art, their implements for cultivating the soil were rude, clumsy, unhandy and unartistic to the last degree.

That the early Greeks, for instance, to whom we are constantly referred for examples of marvellous beauty in architecture, sculpture and painting, of wondrous eloquence, poetry and philosophic learning, had among them mechanics of the highest skill, is manifest by the magnificent armor and equipments of war as described by Homer, Hesiod, and later by Virgil, and by the exquisite gems and jewelry constantly found beneath the soil of that classic land, showing us in their refined savageness those ever-present traits of an unchristianized people, a special devotion to the art of war and to their personal adornment.

It certainly seems strange that a people who lived among such matchless architecture as their shrines and temples, who gazed on the exquisite statuary of Phidias and Praxiteles

and the lovely paintings of Apelles, Zeuxis and Parrhasius, who applauded the grand tragedies of Æschylus and Sophocles or the eloquence of Æschines and Demosthenes, who drank inspiration from those fountains of philosophy and wisdom, Socrates and Plato, should have so entirely neglected the art of agriculture and the cultivation of the soil; and in that occupation of life which furnished them their daily sustenance should have bestowed no thought nor care to improve the means by which it was procured. They, whose soldiers wore elegant armor and carried highly finished weapons, whose nobles and women wore curious and exquisitely wrought jewelry, scratched the surface of the soil for the reception of the seed, as their ancestors did, with the crooked limb of a tree, harvested the crop with an indifferent reaping-hook, threshed it under the slow tread of the muzzled ox or the livelier movement of horses on a chariot, winnowed it with the wind of heaven, and finally ground it by the slow process of the hand-turned millstone.

Nor had the Romans, a century later, with all their boasted triumphs in war, law, science and the arts, progressed much further in the mechanical appliances of the farm. The improvement in farming tools was very slow till well down into the seventeenth century, and has been more rapid and positive during the past hundred years than in all previous time. Virginia, as early as 1610, had a glass-house, smelting furnaces, and manufactories of pitch, tar, potash, and some other articles for domestic use and exportation. Within twenty-five years from the settlement of the Colony of Massachusetts Bay, the people had built mills, discovered the existence of iron ore, erected furnaces and commenced the manufacture of various articles, among which were some farming tools, so that the origin of American agricultural implements may almost be said to have been commenced with American manufactures, at the settlement of the country.

This event carries us back to a period anterior to the discovery and application of nearly all those great instrumentalities in science and mechanism which have revolutionized the industrial aspects of the world, and controlled its social, moral and political condition.

At that time the latent energy of steam, and the subtle agency of the electric fluid were scarcely suspected; the cotton-gin, power-loom, spinning-jenny, mowing, reaping, and sewing machines were unimagined. The lucifer match, illuminating gas, and the photograph, with an infinity of applications of the principles of nature now most familiar, were then unknown, and the great discoverer of the law of universal gravitation was himself unborn.

Indeed, brief as the intermediate period has been, compared with the ages of the past, it covers nearly all the improvements that now are deemed of the most essential importance. The art of printing, it is true, had been discovered, but stereotype plates, cylinder and power presses, lithographic and other forms of engraving, and most of the improvements which have made "the art preservative" the most potent agent of civilization, are of most recent origin, and are children of the brain's later birth.

The mariner's compass had been invented, but the quadrant had not, and chronometers were unknown, while the thermometer, barometer, and even the telescope had hardly revealed their uses. Ship-building was comparatively a rude art, and the geography of the sea entirely unwritten.

Those great agencies of mechanical industry which have augmented a thousand-fold the productive power of man, and proportionally increased his comfort, as the use of fossil coal and the blast furnace in the smelting of iron, of gunpowder and steam in mining, of the flying shuttle, spinning-frame, power-loom, and carding machines, and improvements in bleaching, dyeing and stamping in the textile manufactures, and the wonderful discoveries in chemistry, analytical and agricultural, and the wondrous helps to farming, all belong to a subsequent period. Cotton, which now employs millions of people and millions of capital in its growth and manufacture, and furnishes the clothing for many more millions, was not long before regarded as a curious exotic. The fire-engine, safety-lamp, life-boat and life-preservers, gas-light, the tourniquet and chloroform, and many other appliances for the conservation of life and property, were unknown in that era.

In short, whatever proficiency may have been attained in the arts of civilization in the early ages, we may say truly

that their present development from a state of almost barbaric rudeness has been contemporaneous with the history of America, of which our manufactures form a large part, where, too, especially in later years, our agricultural machinery and implements occupy no mean position.

The first settlers in America brought with them to these shores a knowledge of most of the arts and manufactures of the parent country, as will be evidenced by a list of those sent over to Virginia and the Southern colonies, established under royal patronage, as well as those voluntarily settling in the more Northern colonies. Husbandmen, brewers, bakers, sawyers, carpenters, shipwrights, millwrights, ploughwrights, masons, turners, smiths of all kinds, coopers, weavers, tanners, potters, shoemakers, rope-makers, edge-tool makers, brick-makers, dressers of flax and hemp and leather, lime-burners, men for iron works, mining, and for glass-making.

Many of these men were accustomed to the comforts, and even what were considered luxuries, in that era of civilization. Their primary wants in their new homes were those of subsistence, shelter and clothing; these could only be supplied by their own energy in subduing the unbroken forest and the virgin soil, which labors again required for their rudest exercise the implements of husbandry and other mechanical appliances, and these they began to shape for themselves as soon as the severest emergencies had passed, and the tools brought with them began to fail and be insufficient. To obtain the means of ameliorating their condition, the colonists, whose only wealth was the strong arm and the iron will, were forced to rely mainly on their own unaided exertions. This was particularly the case with the first settlers of New England, whose expatriation was a voluntary one in behalf of their principles, which left them without that support and patronage which watched over the more speculative enterprise of the earlier and wealthier colonists on the more southern territory.

The improvement in agricultural machinery during the first century and more of our existence, though much discussed and greatly needed, was slow. The early settlers were able, with such tools as they had, to raise and harvest

crops enough for their support and some for export, but the inventive and mechanical genius of the new country was more absorbed in building houses, mills, factories, tanneries, glass-houses and ships, for shelter, clothing, and transporting from the country those products which would bring back into the country such necessaries and luxuries of life as could only come from foreign ports, than in devising easier methods of cultivating the land and securing the products of the soil.

But the advance in the agricultural development of this country, following manufactures and commerce, has for the past seventy-five years been very great, and is undoubtedly due largely to the creation and perfection of farming tools, implements and machines. The published transactions, during the first quarter of this century, of "The Massachusetts Society for the Promotion of Agriculture," "The Philadelphia Society for promoting Agriculture," "The South Carolina Society for promoting Agriculture," and various other publications, show that the theory and principles of agriculture in the preparation of the soil, the seeding and cultivation of crops, the production of wool, and the care and feeding of cattle were about as well understood eighty years ago as at the present time; while in the practical results, it is doubtful if we equal in amount the crops then raised.

True, we have greatly progressed in breeding domestic animals, in the introduction of new and better varieties of plants, fruits and seeds, and in the use of special fertilizers, however much that may be; but as a single item, the improvement and manufacture of our farming tools, implements and machines seems pre-eminent.

During our provincial existence, the mother country endeavored to repress the growth of all manufactures, except such as would directly contribute to her commerce, and of the machinery necessary for them; but as soon as the people of the new country had partially recovered from the shock and the losses of the war, and realized their destitution of those articles, attention was turned to providing themselves with the necessaries of life from their own resources. With such tools as they possessed, or could be singly wrought out by the blacksmith or wagon-maker, their simple food could be

wrested from the earth, but the requirements of a rapidly growing population demanded more speedy results than mere hand labor would furnish for clothing, building, and the many articles of household necessity or convenience. Accordingly we find, among the earliest, those directed to the raising of sheep for wool, the cultivation of flax, and the production of woollen and linen cloth, by machinery driven by water power. Flax was grown in large quantities in some parts of the country, and both that and wool were largely spun and woven by hand.

Cotton was first used about the middle of the century, and nearly as soon here as in England, but only on a filling with linen warp, and it was another hundred years before any weaving was done in a power-loom.

Mills for the manufacture of iron and for cutting nails had been early introduced, but had been discountenanced, and even suppressed by the British government, as had also the exportation from that kingdom of many other kinds of machinery, it being the settled policy of that government to force the colonists to buy their manufactured goods in the old country.

In 1810, Judge Peters of Philadelphia, one of the most eminent agriculturists of his day, and most patriotically zealous in his attempts to improve the agriculture of the country by his writings and practice, wrote an essay on the propriety of establishing an "agricultural implement manufacturing company," urging the necessity of it with great force, and saying that there was not in the country a manufactory of agricultural instruments in general; that although such implements as we have are often hand-made, and intrinsically good, yet they were not easily obtained nor readily multiplied.

These wise suggestions, however, seem to have failed in producing any practical results. In the process of time, imperious necessity, aided by our system of patent laws, began to accomplish great ends. The first law for the protection of American inventions was in 1790. The first patent on record was issued to Samuel Hopkins for the manufacture of pot and pearl ashes. The first patent for spinning cotton by power, was by Pollard, in 1791; for power-

loom, by Whittemore of Massachusetts, in 1796; and till within a short time previous to this, all the spinning and all the weaving of woollen, linen and cotton goods was by hand-power. Among other famous inventions was that by Jacob Perkins, of a machine for cutting nails, in 1786, but patented in 1795.

In 1776, in Sutton, in Worcester County, was a gun factory, which after the war was converted into a manufactory of scythes, axes, and other tools; and before 1790, there were in that town five scythe, one axe, and one hoe manufactory.

In 1790, in Amesbury, Essex County, several kinds of agricultural tools were made in considerable quantities. In 1798, in Plymouth and Bristol counties, were fourteen blast and six air furnaces, twenty forges and shifting mills, in addition to a number of trip-hammers, and a great number of nail and smith shops. Many branches of iron and steel manufacture had grown up in their neighborhood; and cut and hammered nails, shovels, spades, scythes, saws and other implements were made in large quantities. Charles Newbold took the first patent for an iron plough, in 1797. Oliver Ames of Massachusetts patented shovels and spades in 1811, and the same patterns are made to this day. At the Centennial Exhibition, in the same case, stood those made in 1811 and in 1876. Scythes were early made by machinery, probably the first agricultural implements in this country that were. The system of granting patents for new inventions, which is the great stimulus to improvement, had its rise in England early in the seventeenth century, and has been since adopted by most civilized nations. In the system of laws called the body of liberties, adopted by the general court of Massachusetts in 1641, was a law on this subject. It declared that there should be "no monopolies, but of such new inventions as were profitable to the country, and for a short time only."

One of the first applicants for exclusive privileges under this first New England code was Joseph Jenks of Lynn, who came to the province in 1645, and in the following year presented a petition for a patent for a new application of water power to mills for various uses, including a saw mill.

On the 6th of May, 1646, the court resolved "that in answer to the peticion of Joseph Jenkes for liberty to make experience of his abilityes and inventions, for ye making of engines for mills to goe by water for ye more speedy dispatch of worke than formerly, mills for ye making of sithes and other edged tools, with a new invented sawe mill, that things may be afforded cheaper than formerly, and that for fourteen years without disturbance of others setting up the like inventions, that so his study and cost may not be in vayne or lost. This peticion is granted so as power is still left to restrain ye exportation of such manufactures and to moderate ye prizes thereof if occasion so require."

This Joseph Jenks was a remarkable man, and might be called the "Tubal Cain" of this country, as he was the first founder and worker in brass and iron on this continent, and he certainly was the first to make any agricultural implements by machinery. The first threshing machine patented in this country was in 1791, and was soon succeeded by many more. The war with Great Britain in 1812, however, stimulated invention and manufactures amazingly.

From 1809 to 1819, from twenty to forty patents were taken out on each of the inventions we have mentioned above.

The three great problems to be solved in the practical operations of agricultural machinery were: first to skilfully, effectually and cheaply prepare the ground for the reception of the seed, and to cultivate the growing crops; second, to harvest them; and third, after harvesting, to prepare the various grain crops for use or transportation.

Of the first, the plough, as the most important, takes the precedence of all others, having been used time out of mind as the symbol of agriculture, and as the most ancient and common to all ages and countries, as far as is within our knowledge of history.

The plough and ploughing are early mentioned in the sacred writings. Perhaps the most notable passage is that in the book of Kings, where Elisha, when called to prophesy, is represented as ploughing with twelve yoke of oxen, — upon which an old Dutch commentator remarks, "that if Elisha

had such 'breaking up' to do, it was no wonder he quit farming and turned to preaching."

For hundreds of years, the plough was, while the most necessary, yet the most clumsy of all implements in use, rivalled only by the flail; and it is only about one hundred years since the old-fashioned mould-board, hewed from a plank and shod and strengthened by iron straps, was superseded by a cast-iron ploughshare.

But little advance had been made in the old country, when Charles Newbold of New Jersey, in 1797, patented the first cast-iron plough ever used in this country; "being of solid cast-iron, consisting of a bar, sheath and mould-plate, serving for share and mould-board; that is, to cut and turn the furrow."

Jethro Wood of New York, in 1819, was the first in this country to cast the plough in sections, so that the part most exposed to wear might be replaced by another cast from the same pattern. Large numbers of ploughs were made from patterns furnished by him, and even to this day there are many ploughs made in various parts of the country, which depart very slightly from the principles established by him, which were the peculiar lines of the mould-board. There can be no doubt that this plough became very popular, and did more to drive out the wretched and clumsy ploughs of the olden time than any other which had then been invented.

Mr. Wood was so harassed by infringers and by lawsuits, that he made nothing by this most important invention, and died poor. Many years after, the legislature of New York, in consideration of the immense benefit from his invention to the people of the country, donated the sum of two thousand dollars to his daughters.

From this time the iron plough became a success, and hundreds of patents have been issued for improvement in the curves and lines of the mould-board, the form of the beam and landside, the cutters, wheels, and various attachments for easing and regulating the draught.

The "swivel" or "side-hill plough," or as it is termed in Scotland, the "turnwrist," has been used in Kent, in England, for more than one hundred years, and, as modified for use in our country, is one of our most useful implements on

flat lands, as on side hills; the furrows can be turned in the same direction whether going or coming, the hateful "dead furrow" is avoided, and the team is a little rested in turning.

One of the earliest laborers in this field was Thomas Jefferson, formerly president of the United States, who, in a communication to the French Institute, attempted to solve the mathematical problem of the true surface of the mould-board, and to lay down intelligible and practical rules for its formation for the first time. He saw very clearly, and was the first one to discern with distinctness, that the plough should consist of two wedges, one acting vertically and the other laterally, which should be so blended in a curved surface that the furrow should rise and turn over smoothly and continuously.

There can be no doubt that Mr. Jefferson is solely entitled to the honor of inventing the first mould-board made on mathematical principles.

In 1790, he mentions that one of his nephews, Col. Randolph, had invented an ingenious and useful plough for turning the furrows on a hillside in one direction, and gives a sketch and plans for making it which shows that he very clearly understood the principles of the plough.

These, as well as the straight ploughs, have been constantly improved and beautified in shape and lines.

The next step in advance in ploughing or turning up the soil for cultivation will be to accomplish the operation successfully and economically by the use of steam. While great labor and study and much money have been expended on this matter, it must be confessed that so far it has been but partially successful.

The great desideratum, which has at several periods during the past forty years seemed just to have been reached, has failed, and after great expectations we found disappointment. That was to drive the ploughs by locomotive power; to construct an engine powerful enough to drive or draw a gang of ploughs or diggers, and yet not so heavy but that it could be moved fast enough to plough profitably. We believe the time will come when it will be found possible and practicable by our greater knowledge of the application of forces

to construct an engine capable of not only running over a common road, but in a cultivated field, where the entire power of the engine shall not be expended in its own propulsion, but have the ability to overcome the resistance of the ploughs. The most notable failure of this attempt was that of John W. Fawkes of Lancaster, Pennsylvania, who invented and constructed an engine capable of drawing eight ploughs, which on a hard sod seemed to accomplish wonders, ploughing at a rate of over four acres an hour. It has never done it since.

So far, the only successful steam plough has been that patented by John W. Fowler, in England, in 1854, and in this country in 1856, or by inventions and devices similar in principle.

This consists in hauling the ploughs back and forth across the field by a stationary engine placed on one side of the field, which, however, can be moved as occasion requires. On the other side is a movable capstan, around which ropes or chains pass from a drum on the engine; the ropes are each fastened to the frame containing the gangs of ploughs facing in opposite directions, and which are thus drawn back and forth. This, though successful, is very expensive, and cannot be profitably used on a farm of much less than two hundred acres of arable land.

So much for ploughing; but the plough, though hallowed by antiquity, the beginner of all earth cultivation, the chosen and long accepted emblem of agriculture, is essentially imperfect.

It has helped toward cultivation, but whatever it has done, has been and is accompanied with a radical imperfection, and that is the damage by the compacting of the subsoil, which is pressed and hardened by the sole of the plough in an exact ratio with the weight of the soil lifted by the share, in addition to the force required to effect the cleavage and the weight of the instrument itself. The invention and use of the subsoil plough are standing witnesses against the plough. The plough, as now used, turns up or over the sod or stubble in a more or less complete manner, dependent on the skill of the ploughman, the steadiness of his team, and the various conditions of the land to be worked, to the depth of from three to seven inches, delusively believed by the honest man

who stands between the stilts of his plough all day long, watching it heave the furrow slice so nice and smooth, and swelling the rich earth as it hurries along, to be from seven to eleven inches. Other instruments pass over it again and again, to make of the rudely upturned furrow a seed-bed fit for use, which is just what we need and must have for success; but they are drawn by teams, tramping, treading and compacting the lightened soil.

Why should we not have an implement which, propelled by some power, should, acting like the tines of a fork or claws of a rabbit, woodchuck, or a mole, tear up, invert and pulverize the soil at one operation, acting probably with a rotary motion, leaving the land in the most perfect condition to receive the seed, whatever that may be.

Ploughing is really but the first of a series of means towards producing a perfect seed-bed. That the plough is not going out of use in this country is proven by the fact that, in 1879, there were made 1,326,123 ploughs.

Next to the plough in the preparation of the soil comes the harrow in all its present different forms; though practically the harrow in most common use is much the same in principle and construction with that used thousands of years ago, —a frame of wood, filled with teeth of wood or iron projecting through the frame, long enough to comb down the irregularities of the furrow left by the plough. Special forms of a harrow designed to accomplish certain work more effectually have proved very successful, — among which stand prominent the disc harrows of "Randall" or "La Dow," now well known, which for cutting up freshly ploughed sod, or for working manure into any ploughed ground, are invaluable and worthy the highest commendation. So also is the "Thomas Smoothing Harrow," in which the teeth, many in number but small in diameter, are inclined backward and so arranged in the draught that every inch of the ground is stirred. One important use of this implement is in harrowing grain, corn or potatoes, soon after they are up; the ground is lightly stirred and the starting weeds uprooted or covered and destroyed, while the crops are not seriously disturbed. About 30,000 of these are annually made.

It is impossible to mention all the harrows, or the seed-

sowers and planters which are next in succession in tillage. Where wheat is grown in large quantities, the general practice is to drill it in with ingeniously constructed machinery. Other grains are commonly sown broadcast; potatoes dropped by hand; Indian corn planted by a dropping machine, often drilled in, and on small farms still planted by hand with the ever-faithful hoe, which also does great service in the subsequent cultivation of the crop. We make about 80,000 seed-drills and planters annually. Horse-hoes and cultivators of innumerable forms, 320,000 in number, bear a large part of the cultivation of hoed crops and are all of very modern use, but now, in the cultivation of the immense fields of corn, potatoes and roots in some parts of our country, seem indispensable.

Of all agricultural operations, that which for years seemed to baffle invention, and to stand in its original simplicity while other operations on the farm were lightened in labor and enlarged in capacity, was that of mowing and of reaping.

The lines of the plough had been lengthened and beautified almost to the perfection of the implement; harrows, rollers, clod-crushers and pulverizers for reducing the soil to the required condition for tilth; seed-sowers and planters for uniformly and rapidly dropping the seeds; horse-hoes, scarifiers and cultivators for cleaning and aiding the growing crops; tedders and horse-rakes for the hay crop; and for the grain, threshing and winnowing machines by the score, had been brought forth and were multiplied; but the invention of man had not been able to conceive anything to supersede the original sickle and reaping-hook, and the primitive scythe remained just as Joseph Jenks of Lynn, in the province of Massachusetts Bay, made it in 1655, in which year he received a patent from the General Court "for welding a bar of iron on the back of the scythe blade to strengthen it and give it greater length, thinness and capacity of cutting;" and that scythe has descended to us of this day unchanged.

After many abortive attempts, both in Great Britain and in this country, to make a harvesting machine that would be satisfactory, the first really successful one was invented in Scotland by Mr. Patrick Bell, in 1827.

The history of Mr. Bell's invention and the difficulties he

experienced in perfecting it and making a working machine is so interesting that I will give it in a brief form : —

In the summer of 1827, while on his father's farm where he had been brought up, having been recently graduated at a university, he was much impressed with the amount of hard labor in the hay and harvest field, and gave his whole attention to devise some way to lighten it. Scheme after scheme had been canvassed and been rejected, and he was almost in despair of accomplishing it, when one evening in his father's garden he chanced to notice a pair of hedge shears. His mind full of the subject, it flashed across him that there was the principle that must succeed.

Adjoining the garden was a field of unripe oats, in which he tried the shears successfully ; but how to reduce this cutting principle to practical working, the great difficulty with most inventors, was his next and most serious study. He first prudently made a model to see how it would look and act. Having accomplished this, he next went to work on a machine, all of the woodwork of which he made himself; and he also made patterns of every bit of iron-work, every wheel, rod, bolt and cutters in wood, and sent them at different times and to different places, to have exact copies made by the blacksmith and the founder. These he had to fit up himself with files and chisels, so careful and fearful was he that some one would see or suspect his work. The machine was finally completed, but how was he to try its working power, unseen and unknown? It stood in his workshop, an unoccupied outhouse, long and narrow, with a bench at one end. On a quiet day, when few were about, with a wheelbarrow he covered the floor of the outhouse with about six inches of soil and tramped it firmly ; then, selecting a sheaf of oats from a convenient stack, he stuck straws in the soil about as thick as they would naturally stand if growing ; then going behind his machine he pushed it forward with breathless anxiety, relieved only by seeing the straws perfectly cut. Much yet was to be done to complete it according to his ideas. A reel must be attached, and an endless apron passing over rollers in front to catch and discharge the cut and falling grain.

These were all finished in the summer of 1828, and, scarcely

waiting for the grain to ripen, he, with his brother whom he had taken into confidence, fearful of being seen and ridiculed, took out the machine and an old horse into a wheat-field about eleven o'clock on a dark night, when every one else was in bed, and after one or two trials they found it to cut the wheat perfectly and to drop it beside the machine; and they took it back to the shop in a happy frame of mind. This machine cut the grain on his father's and brother's farms for more than twenty years. Many machines similar were made, but most of them failed from some defect in the manufacture. A similar experience was had in our own State in 1858.

The Heath Mower took a thousand-dollar premium as the best machine in a competitive trial, arranged by the "Massachusetts Society for the Promotion of Agriculture," and there was never a machine of the same kind made that could do a day's work.

Although Mr. Bell's machine was the first that really performed practical work, — because he hit the only practical device, the shears-cut now used by all mowers and reapers which have been invented and which do efficient work, — many attempts had been made before his to mow or reap by machinery. In the first century of the Christian era, Pliny, the historian, writes that in the vast domains of the province of Gaul (now France), the grain was harvested by a machine consisting of a large, wide box with sloping sides, carried on two wheels, the front board being lower than the others, and having projecting from its edge a great many small teeth, wide-set, in a row corresponding to the heads of the grain, and turned up at the ends. On the back of the machine, two short shafts are fixed; in these an ox is yoked, with his head towards the machine. When the machine is pushed through the standing grain, the heads are caught by the teeth and dropped in the box behind, the driver setting the teeth higher or lower as the condition of the standing grain may require. After eighteen hundred years, the same thing is revived as a header for gathering clover seed; and it is also about the same length of time before any attempt was made to reap by machinery.

The first patented reaper was invented by Boyce, in Eng-

land, in 1790, having six rotating knives swung beneath the frame of the machine. For forty years inventions continued to be made; but with no positive results, till Hussey, in 1833, invented a machine having all the essentials of the true reaper and mower. McCormick was next, and from that time to the present invention has never ceased, and patents almost without number have been granted for every different part which goes to make a complete mowing-machine or reaper. Of these machines, mowers, harvesters, reapers, and reapers and mowers combined, there were made the past year, about 180,000. A notice of reaping-machines would be incomplete without special mention of the automatic binder, the most effective of which is made by the Walter A. Wood Company. It cuts the grain, drops it on the platform, rakes it into gavels, binds it with a string band, and throws the sheaf off for the gatherer; the most perfect agricultural machine ever made, and a marvel of the continued and combined ingenuity of many inventors.

Following the mower is the tedder, a most valuable instrument for spreading the cut grass, throwing it in the air and leaving it lightly on the ground more rapidly and effectively than can be done by five men with forks. This was invented in England, in 1816, but never used in this country till one was imported by the "Massachusetts Society for Promotion of Agriculture," in 1858; since that, several patents have been granted for improvements on it, and it has deservedly come into general use. About three thousand were made last year.

The horse-rake is comparatively modern even in England, and, used in this country thirty or forty years, it is now regarded as a most useful assistant in hay-making, and they are made in great perfection. About 100,000 were made last year. Horse hay-forks for unloading are somewhat used, and for loading hay; about 10,000 machines were made last year.

The threshing-machine — next to the reaper in the practical operations of a grain-growing farm — was the outcome of necessity and invention long before the ingenuity of man had been able to solve the problem of cutting the grain by machine power.

Of all the implements of husbandry, the flail is the rudest

and clumsiest to effect the purpose for which it is designed; and, though used for so many years, it is but a single step in advance of the primitive method of threshing, in the earliest recorded history of agriculture, sacred or profane; that of treading out the grain by oxen or horses.

The Romans, in addition to the treading of oxen, had them haul over the grain on the threshing-floor a heavy drag with spikes, or a roughened sledge called a *tribula* — whence our word tribulation. The practice of treading out grain by horses after the manner of the ancients was in use in this country as late as 1790, especially in the eastern parts of Virginia, Maryland and Delaware, and the planters there claimed its advantages over the flail, as used in the Northern States and in England at that time, to be, that an entire crop could be beaten out in a few days, thus securing it from the ravages of the Hessian fly, which even then prevailed there, and also from thieves; and also that of having it earlier ready for market.

Three thousand bushels of wheat could thus be made ready for market in two days, which would employ five men with flails a hundred days. Treading-floors were made of a hard, waxy earth, which by use became firm, glossy and smooth. These were made from sixty to one hundred and thirty feet in diameter, with a path or track at the circumference twelve to fourteen feet wide, on which the sheaves were laid, usually fenced around, sometimes with an outer and inner fence. The horses were led round in ranks equidistant from each other, and in a sober trot; thus four ranks would preserve the relative position of the four arms of a wheel. Somewhat the same method was practised on the California coast, down to the time when the discovery of the golden grains in the raceway of Col. Sutter's mill gave the first start to that marvellous settling of the Western coast of this country.

As described by one who was there, and who afterwards became a member of Congress and one of California's most respected and respectable governors, it was thus: Col. Sutter had a large mill for the production of flour, for consumption along the whole coast line and for exportation. To supply his mill with wheat, he had hundreds of acres sown to that grain. When it ripened, — the season of ripening con-

tinuing, as it does there, for some weeks without rain, — he would send to the mountains for part of a tribe of Indians to come down and help reap it. The noble redmen would respond for a small compensation, and would come on to the number of fifty or a hundred. All the sickles and old swords that could be found were first taken; then sickles were extemporized from old iron hoops, and if more were wanted, willow shoots the thickness of a man's thumb were cut, pulled and split; when dry the sharp edge was sufficient to cut or break the stalks of wheat.

When cut, the grain was carried and thrown to the depth of about two feet in a corral containing a half-acre or more, prepared for the purpose by setting in a circle in the ground posts ten or twelve feet high, and binding to these posts long poles with strips of green hide, which, when dried, held like straps of iron.

When this was completed, a drove of wild horses to the number of a hundred was brought in by the stockmen, and turned into the corral to trample out the wheat. These were kept in lively motion by the Indians, round and around the outer limit of the corral. After driving them in this direction a sufficient length of time, the order would be given to turn them, to tread the straw in a different direction; and then comes the acme of excitement. A hundred frightened horses are dashing around, and a hundred ragged redskins attempt to turn them; the horses kicking, biting, squealing, plunging, — the Indians, in the perilous endeavor to throw themselves in front, whooping, yelling and swinging their clubs in frantic endeavor to turn this mass of wild horseflesh, with sometimes an Indian down and sometimes a horse, but finally successful; all making a wild scene of life, never witnessed except in California, and seldom there.

Of threshing-machines — among the most necessary of our agricultural implements, from its importance as a means of economizing both labor and time — the first practical invention was by Andrew Meikle of Scotland, in 1786, which is the type of all modern machines. The winnower was added in 1800. Samuel Mulliken was the first American inventor, in 1791. In threshing-machines as well as in reapers, the American inventors, though subsequent to the English in

their original principles, far excelled their brethren across the water in making improvements, rendering them much more convenient and practical in their operation. The American machines are much lighter than the English, much easier handled and run, much cheaper, and thresh more than twice as much grain, and clean it better; which was proved at a trial on Mechis' farm in 1853, at Tiptre Hall, in England. About 10,000 are annually made.

Having traced the excellent modern machines and implements for raising and securing the farmers' crops, and separating the seed from the straw, the next valuable instrument which deserves attention is the winnowing-machine, or fanning-mill as it is commonly termed, for separating the grain from the chaff.

According to all history, sacred and profane, the common and only mode of accomplishing this was by throwing the whole into the air by means of a long, shallow basket called a fan, at such a time as there was wind enough to blow away the chaff and dirt.

The first winnower containing all the principles of those in present use, was made in Scotland, in 1710, by Andrew Meikle, who brought the ideas from Holland which since, both in Great Britain and in this country, have been so thoroughly elaborated into the machine which has now become indispensable. It is among the histories of the machine that when it was first introduced in Scotland, certain sensitive persons denounced it as an impious device, "as it created a wind where the Lord had made a calm." Of fanning mills there were constructed during the past year about fifty thousand. Corn-shellers, both those worked by power and by hand, are, of course, an American invention, and of great consequence and utility. Thirty or forty patents have been granted in this country for this valuable machine since 1810, the date of the first.

A curious record with a drawing is among the English patents, as follows: "Letters Patent to Thomas Masters of Pensilvania — Planter, his Exrs. Admrs. and assignes, of the sole Use and Benefit of a New Invencion found out by Sybilla Mathews his wife for cleaning and curing the Indian Corn growing in the Several Colonies of America dated Nov 25th

1715." The drawing shows a set of stamps worked up and down by lugs on a horizontal shaft driven by a water-wheel, there is also the drawing of a kiln for drying the corn. Over sixty thousand corn-shellers are annually manufactured in this country. The grain cradle has performed a very important part in our agriculture, and apparently still does, as over one hundred and sixty-eight thousand are made every year.

This implement, or improvements in it, have been patented many times since 1800.

Its origin is not given by any writer that I can find. Barnaby Googe, in his "Historie of Husbandry," in 1584, says, "besides sickles with a toothed edge, where the grain is tall they use a large scythe, with a long handle fenced with crooked sticks, which they swing with both hands."

As an agricultural machine, none has ever been invented which has surpassed the cotton-gin in its importance, from the change it has wrought in the cultivation and production of that great staple so long vaunted as King Cotton, by which the clearing of the lint from the seed was increased in production from the four pounds by hand, or twenty-five by the old roller-gin, to one thousand pounds daily.

In the cultivation of potatoes one of the most expensive items is the digging or lifting them from the ground. Several patented machines were exhibited at the Centennial Exposition, but none seemed to the judges worthy of commendation, yet the thirty-five thousand made last year show that there must be an appreciation of them somewhere.

The improvements in every branch of dairying have been such as to have almost revolutionized the management of milk in making butter and cheese, both of which are now largely and successfully made in creameries or cheese factories. Churns to the number of over two thousand have been patented since 1803; some of them with strange devices, and more than one, as a labor-saving machine, has a rocking-chair combined with a churn; milk-pails, strainers, shallow pans and deep pans, milk-cans, coolers and creamers with submerged pans and with open pans exposed to an iced atmosphere, butter-makers and moulds, cans for collecting cream and milk, machinery for making butter and cheese in quantity, cases and packages for sending choice butter to

market, and hundreds of devices, not imagined twenty-five years ago, have been patented, and used or discarded as they were proved valuable or worthless.

Forty-five thousand corn-huskers annually made show a considerable use of that convenient machine. One, patented by Phillip of Stockport, New York, works very successfully, accomplishing the work of four or five men; the ears of corn are dropped from a hopper on one or two pairs of gently inclined iron rollers having iron studs projecting about a quarter of an inch, running in a spiral direction around each roller; as these rollers are made to turn in or toward each other, the husk is caught by the studs, stripped clear, and discharged underneath the machine, while the husked ear passes clear off the ends of the rollers.

Machines for distributing special and also liquid fertilizers have been long used in England, and to a limited extent here; but I think the first practical machine to spread barnyard manure, long or short, or compost, is the Kemp Manure Spreader recently invented and introduced, and seeming to do its work satisfactorily, especially if used in spreading from a heap in the field drawn out the previous season, doubtless the best practice.

It seems strange that the dump-cart now so commonly used with a pair of horses should have only come into use within the last twenty-five or thirty years. While we have had our ox-carts and one-horse carts which unloaded by dumping, we could only use a pair of horses on a wagon, as there has been no device for resting the neap of a cart on the backs or necks of horses.

Whoever the man was that had the genius to cut off the neap of his ox-cart about half-way, and by putting in a king-bolt through the end into the axle of the fore wheels of his wagon, to make a cart easily drawn by horses, to turn handily, and to dump the load readily, he deserves to have his name perpetuated. Our neat and handy carts and wagons contrast with the necessities of the early settlers, and most strongly with those of Virginia and Maryland, who lacked the all-conquering, persistent energy of the colonists of Plymouth and Massachusetts Bay.

The transportation of tobacco in the absence of travelled roads is thus described in "Beverly's History of Virginia."

The tobacco was very solidly pressed into large hogsheads; in each end of these, through the heads, was driven a round pin, some two or three inches in diameter, with a square, sharp point; each pin projected some eight or ten inches from the head, and on these, forming axles, was attached by withes a rude pair of shafts made from saplings, and thus the hogshead of tobacco was trundled like a great roller, from the interior, miles to the seaport for shipping.

Of the countless small tools we use on the farm, I have said nothing; they generally have no history, except as being improvements on the rude instruments used by the successive generations that preceded us. Suffice it to say, that in lightness combined with strength, ease of working, efficiency for their intended use, and beauty and style of finish, our farming-tools are vastly superior to those of any other nation on the face of the earth, the farmers of Britain not excepted.

One very noticeable feature in the use of most of our agricultural machines is the driver's seat. I believe this was first found on the reapers and mowing-machines, and has now grown on all our rakes and tedders, on sulky or gang ploughs, on harrows and rollers, on seed-sowers and planters, on horse-hoes and cultivators, and on every machine where it can be perched, in entire contrast to the customs of all other nations, none of whom have ever made use of the seat on any machines except those that originated in this country. It was a necessity on the mowing-machines, and has been continued on the others as a convenience, and probably it is on most machines a matter of economy. A man will much easier manage his team when riding than walking behind or beside it, and it husbands the man's strength without any great strain upon the horses.

The value of the agricultural machinery and implements in Massachusetts, as shown by the census reports of each decade, are: for 1850, $3,209,584; for 1860, $3,894,998; for 1870, $5,000,879; for 1875, $5,321,168; for 1880, nearly $6,000,000; a very gratifying growth.

The increasing annual products of agriculture in our highly favored country, and the hay and grain crops in particu-

lar, furnish striking illustrations of the close interdependence and connection of all branches of the national industry. The dependence of agriculture upon the results of mechanical skill, as well as the astonishing progress of the latter within the last seventy-five years, is strongly exemplified in the application of labor-saving appliances in all the operations of the farm. Our own progress in this respect is more rapid than that of any other agricultural people, and at least co-equal with our application of the fruits of purely scientific research in the improvement of agriculture.

In every department of rural industry, mechanical power has wrought a revolution. The greatest triumph of mechanical skill in its application to agriculture is witnessed in the instruments adapted to the tillage, harvesting and subsequent handling of the immense grain crops of the country, and particularly on the great plains of the West.

The two all-important elements which have been combined to improve, elevate and sustain our agriculture, enabling us from a hard and reluctant soil to draw not only our own sustenance, but such a surplus as has made us strong and prosperous, are, agricultural chemistry and agricultural implements and machinery. The chemistry of agriculture has taught us, first, the importance of draining and subsoiling, loosening and aerating the hidden depths of the soil, that plants may there find proper moisture and sustenance; it has taught us somewhat the mysteries of plant-life, and how plant organisms are developed to full maturity; it has taught us that plants do not obtain all their elements of growth from the mingled rock-dust and humus which constitute soil, but, wonderful as it may seem, they draw from the atmosphere almost alone solid forms of plant organisms; it has taught us respecting the offices of the soil, the rain, the air, heat and moisture, in accomplishing the development of plant-life; it also teaches us that in supplying the food necessary for vegetable growths, different plants require different nutriment.

It has clearly and minutely explained to us the nature of fertilizers, and how they become plant food, and wherein consists the value of our farm-yard manure, and how it may

be supplemented in another form by chemical elements which, when applied, nature assimilates to the want of the plant. It has taught not only how to use these special fertilizers, but also to distinguish between those which are genuine and valuable, and those which are fraudulent and worthless. In a word, agricultural chemistry has done more than any one thing else during this century to elevate the hard-working but intelligent farmer from a mere imitator, in his cultivation, of those who went before him, to be a reasoning, thoughtful manager of such elements as are under his control.

And these teachings have not been confined to the laboratory, nor reserved only for the learned and wealthy; as they have by slow degrees been brought to the general comprehension of the farmers, those principles and doctrines which but a few generations since were utterly unknown, and in the succeeding ones derided and ridiculed as book-learning and fancy farming, have now become a part of our common education, and are taught to the children in the schools and applied by the fathers on the farms.

While the acquirement of this scientific knowledge has tended to elevate and expand the ideas of the farmers, improved machinery as an adjunct has enabled them to employ more brain work in the management of their farms, at the same time reducing the amount of the severest physical labor, while increasing their productiveness.

For of what avail would be the largest accumulation of scientific theories without the means of carrying them into practical operation and making them available for our necessities? They would be like those beautiful visions which sometimes appear to the exhausted traveller on a desert plain, when famished with thirst, tempting him with a delusive view of "water in a dry and thirsty land where no water is," as unapproachable and unattainable as the fair fields of the "promised land" were to the prophet, sage and warrior, who from Nebo's lonely mountain longingly gazed at them with the melancholy consciousness that they could never be within his occupation nor under his control.

While agricultural chemistry has shown us the *possibilities* of improvement and success in our farming, agricultural

machinery and implements have given us *opportunities* which we have so largely and successfully used in combination with our scientific knowledge, as to have placed ourselves and our Commonwealth in the foremost rank of scientific agriculture in the United States.